GREEN CHEMISTRY AND BIOREMEDIATION: INVESTIGATION OF METAL INFLUENCE FROM CATALYSTS ON MICROORGANISM CONSORTIA WHICH IS USED IN BIOREMEDATION

T. Jednak[1], J. Avdalović[2], S. Miletić[2*], V. Beškoski[3], M. Ilić[2], G. Gojgić-Cvijović[2], M. M. Vrvić[2,3]

[1]BREM Group, Ulica oslobodjenja 39b, Belgrade-Knezevac, Serbia
[2]Institute for Chemistry, Technology and Metallurgy, Njegoseva 12, POB 473, Beograde, Serbia
[3]Faculty of Chemistry, Studentski trg 12-16, POB 51, University of Belgrade, Belgrade, Serbia

[a]srdjan@chem.bg.ac.rs

Introduction. Bioremediation can be defined as any process that uses microorganisms or their enzymes to return the disturbed environment to its original condition. It has the potential of complete degradation or transformation of hazardous organic pollutants into harmless products. The use of microorganisms in bioremediation is not limited to detoxification of organic compounds. Some microorganisms can reduce the cations of heavy metals into less toxic and harder soluble forms [1].

Bioremediation pile

Rapid industrialization generates different industrial waste, often mixed with heavy metals. Elevated concentrations of heavy metals can affect almost every index of microbial metabolic activities [2].

For bioremediation of heavy metals on an industrial scale, it is important to use materials such as by-product or waste material [3].

The subject of our study was to investigate if there is an influence of metal catalysts on microbial consortia isolated from a variety of waste materials, which can be used in the process of bioremediation.

Catalysts used in the experimental work were by-products of oil desulfurizer and treated as waste material. Metals to which we were directed attention in this study were molybdenum and cobalt.

Material and Methods. For the preparation of microbial consortium the following materials were used: waste motor oil and soil contaminated with waste fuel oil originated from Belgrade Power Plant.

For toxicity testing 5 different waste catalysts from the process of hydrodesulfurization were used.

Investigation of chemical composition of catalysts included: determination of moisture, pH, ash, n-hexane extractable substances (HES) [4], total petroleum hydrocarbons (TPH) [5], carbonates, CO_2, elemental analysis, determination of total heavy metals (As, Fe, Co, Mo).

The Inhibitory effect of tested catalysts on growth of microbial consortium in nutrient medium was studied using catalyst aqueous extract in concentration range of 250-6000 ppm for molybdenium, and 64-1540 ppm for cobalt.

Identifications of microorganisms were performed by API tests.

Results. The data from chemical analysis of investigated catalysts are shown in table 1.

Table 1. The basic chemical characteristics of studied catalysts

Characteristics		Catalyst				
		1	2	3	4	5
Basic chemical parameters	Moisture (%)	4.0	4.5	9.8	28	12.5
	pH	3.7	3.8	3.54	9.95	2.8
	Ash (%)	91.20	92.71	84.59	7.69	94.00
	HES (g/kg)	5.29	1.39	1.20	/	/
	TPH (g/kg)	2.26	0.57	0.43	/	/
	Carbonates (%)	/	/	1.16	/	/
	CO_2 (%)	/	/	0.51	/	/
Elemental analysis (%)	Total nitrogen	< 0.1	/	/	0.35	/
	Total carbon	2.27	0.32	0.64	83.38	< 0.12
	Hydrogen	0.51	0.65	0.90	2.16	0.54
	Sulfur	2.21	1.81	3.19	/	0.87
Total heavy metals (mg/g)	Arsenic	2.05	0.007	0.31	0.001	2.77
	Iron	4.58	0.932	9.12	2.26	2.56
	Cobalt	7.75	0.002	17.12	0.033	18.65
	Molybdenum	21.46	0.007	52.15	0.055	56.68

All catalysts (except number 4) has the similar basic chemical characteristics. In catalyst number 4 is evidently larger amount of organic supstance. For the further investigation of heavy metals role in the process of bioremediation the catalyst number 3 was chosen due to its higher content of molybdenum, cobalt and iron.

It was determined that toxicity of molybdenum is higher than 6000 ppm and cobalt more than 1540 ppm.

The genera of microorganisms present in consortium are *Pseudomonas, Rhodococcus, Sphingomonas, Achromobacter, Stenotrophomonas* and *Aeromonas.*

Conclusion. Aqueous extract of the catalyst number 3 doesn't have inhibitory effect on consortium at investigated concentration of metals and could be safely used in the bioremediation process.

The results of present study provide evidence that microbial consortium isolated from oil contaminated soil could also be used in the bioremediation process with the presence of wasted catalysts.

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References.

[1] BREM Group web site: http://www.bremgroup.com
[2] G.D. Gojgic-Cvijovic, et al., Biodegradation, **23** (2012) 1
[3] V.P. Beškoski et al., Chemosphere, **83** (2011) 34
[4] EPA Method 9071b , 1998
[5] ISO 16703, Geneva 2004